Report from the Vehicle Emissions Working Group Of the State Advisory Board on Air Pollution

November 28, 2007

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Project Team Charter:

The charter for the 2007 Vehicle Emissions Team project report includes the following: Summarize available information regarding vehicle emissions standards across the United States. Summary to include specific details of each state's standards including California's SULEV standard, stated reasons for following those standards, as well as benefits and downsides of these standards. This project will also explore new approaches, partnerships, and technologies under development or already available to reduce fuel use and vehicle emissions. This project will not include information regarding off-road vehicles.

Project Summary:

In the past few decades, environmental issues have been increasingly prevalent and important in America. One of the largest contributors to air pollution, motor vehicle emissions occur from fuel combustion (carbon monoxide – CO, hydrocarbons – HC, and oxides of nitrogen – NOx) and fuel evaporation directly from the vehicle as well as indirectly from refueling and fuel production emissions. As a result of Motor Vehicle Emission and Fuel Standards, automobile manufacturers must produce motor vehicles with cleaner engines as a result of a number of requirements from the Clean Air Act and the 1990 CAA amendments

Many efforts to produce cleaner fuels have been pursued such as the mandated elimination of lead from gasoline and the required the use of oxygenated fuels. The removal of sulfur from fuel (including diesel fuel) is a more recent effort. During the winter months of 1992-1993, many new oxygenated gasoline programs, including northern Virginia, were implemented to increase combustion efficiency in cold weather and thereby reduce CO emissions. Another cleaner fuel initiative is reformulated gasoline (RFG), which the CAA requires in areas with the worst ground-level ozone pollution, or nonattainment areas. The oxygenate requirement was later removed as it was determined that there was less benefit for modern engines

The 1990 amendments of the CAA mandate that 33 states and localities implement Inspection and Maintenance (I/M) Programs. The tests associated with the I/M program aim to identify motor vehicles that emit too much pollution and need repair.

The US EPA must certify new vehicles before they can be sold in the US. Until recently, one standard was applied to all vehicles of a particular type and weight range. This process was easy for the manufacturers to comply with but had the “least common denominator” effect of providing no incentive for improvement. California took the lead with their Low Emission Vehicle (LEV) program which began in 1992. This concept was followed by EPA with the Tier 2 standards which took effect in 2004. The California LEV program created new environmentally friendly vehicle categories initially including Low Emission Vehicles (LEV), Ultra LEV (ULEV), and Zero Emission Vehicles (ZEV).

Congress established the Corporate Average Fuel Economy program better known as the CAFE program as part of the Energy Policy Conservation Act of 1975. The goals of CAFE standards were to reduce US dependence on foreign oil and decrease the consumption of gasoline. National Highway Traffic Safety Administration (NHTSA) is responsible for establishing and amending the CAFE standards. The standard for passenger cars is currently 27.5 miles per gallon. Proposals to increase the fuel mileage standards for passenger vehicles are now being debated in Congress.

Many of the federal regulations implemented by the EPA were preceded by laws passed in California. The California emissions standards have been consistently more stringent than the federal standards. California’s current non-mandatory programs provide a glimpse of possible federal motor vehicle legislation to come. States generally have the option to follow either the federal requirements or the more stringent California requirements. One group of states, NESCAUM, for Northeastern State Air Use Management, was founded in 1967 and has grown to address the entire spectrum or air quality issues including diesel exhaust, climate change, energy efficiency, and cleaner cars and fuels. Virginia is a member of another state group comprised of 13 states from Virginia to Maine known as the Ozone Transport Commission (OTC). The OTC was instrumental in orchestrating an agreement with the major automobile manufacturers where they would voluntarily supply certain California LEV vehicles to OTR states starting in model year 1999 and other states in 2001.

Motor vehicle regulations are driven by the need to meet the National Ambient Air Quality Standards (NAAQS) and to reduce the mobile source contribution to air pollution nonattainment areas. The regulations also had the benefit of reducing the reliance on foreign oil.
More recently, however, motor vehicles' contribution to greenhouse gases and their climate change and other environmental impacts have become an issue. California adopted regulations, slated to take effect with model year 2009, as part of the LEV program that will regulate greenhouse gas emissions from motor vehicles certified in California. Recently, the US Supreme Court ruled that EPA has the authority to regulate CO2 as a pollutant and therefore so did California.

The current system of gasoline, diesel and alternative fuels standards is complex. There are benefits in simplifying the system so that regional or national standards are consistent. By the spring of 2007, there were 15 different gasoline formulations required across the country. Fortunately in Virginia, we have requirements for only two major specifications for fuels. RFG fuels are required to be sold year-round in most of Northern Virginia, Hampton Roads and the Greater Richmond area. Conventional fuels are sold in all the rest of the areas of the Commonwealth. The "drivers" of the fuels described above are clean air laws on both the federal, state and local level. Virginia coordinates its clean air laws to align with the federal requirements. The requirements for the most part center on the reduction of ozone.

Some states are encouraging or mandating the use of ethanol blends, E-85 (15% gasoline and 85% ethanol) and biodiesel fuels as well. In Virginia, the Energy Policy Act of 2006 "promotes the use of biodiesel and ethanol produced from agricultural crops grown in the Commonwealth. Also, Executive Order 48 issued by Governor Kaine on April 5, 2007 requires all agencies and institutions to maximize biodiesel and ethanol use in state fleet vehicles except where use of biodiesel will void warranties or incur unreasonable additional costs to the agencies.

This report delves into the viability of available regulatory options for Virginia. Examples of such options include expanding Virginia's current I/M program. Currently Virginia's I/M program tests only diesels equipped with an on-board diagnostic (OBD) system. There would be a significant benefit to requiring pre 1996 vehicles to be tested annually. This change would have to be approved by the Virginia General Assembly. Another example would involve eliminating or modifying the readiness exemption for the OBD test since this could capture significant excess emissions. Also, DEQ is currently investigating using remote sensing to identify high polluting diesel vehicles. DEQ could implement diesel I/M by regulation for vehicles up to 10,000 lbs GVWR (and newer than 25 model years). Expanding the vehicle coverage up to 14,000 lbs beginning with model year 2011 for diesels (and model year 2007 for gasoline vehicles) would not require any additional testing equipment, but would require authority from the VA General Assembly. Adopting the California new vehicle certification standards is an option available to states.

This project report includes a discussion of various means which have been proposed to provide incentives for purchasing cleaner fuels and vehicles including: Tax incentives, HOV lane privileges, and scrappage programs.

Also included in this report is a listing and discussion of a number of new ways in which to reduce emissions from vehicles that are currently in various stages of development. Some measures such as the use of ethanol, biodiesel, ultra low sulfur diesel, automatic tire inflation systems, and idle reduction technologies are already entering into the marketplace and are providing for some significant reductions in vehicle emissions. Others such as fuel cell and plug-in hybrid vehicles are still in the research and development phase or are not yet economically feasible but show promise for the coming years

II. History and Background

Introduction

A working group of the State Air Board (SAB) has developed this report to give the Virginia State Air Pollution Control Board (SAPCB) and Virginia Department of Environmental Quality (DEQ) background information on vehicle emissions. This document aims to provide an overview of vehicle emission and fuel regulations and standards, new approaches and technologies available to reduce emissions from motor vehicles, and a discussion of regulatory options to address vehicle emissions.

This report discusses fuel standards, emissions standards, and pollution reducing technologies. In the fuels section, specific figures for the components of the fuels are included as well as descriptions of many alternative fuels currently being utilized and even mandated. The emissions section also gives the detailed standards required by law. The new technologies section discusses some of the methods to reduce pollution air that are being pursued and methods that are still in the finalization stages. The feasibility of these different approaches in Virginia is considered.

This report does not include in its scope information regarding off-road vehicles such as snowmobiles, motorcycles, all terrain vehicles, gas/diesel powered boats, etc.

The Environmental Protection Agency (EPA) Mandate

Brief history of the EPA and the Clean Air Act (CAA)

In the past few decades, environmental issues have been increasingly prevalent and important in America. Attention to the issue of air pollution and the human contributions to it prompted the first federal legislation addressing air pollution: the Air Pollution Control Act of 1955. This act essentially only raised public awareness on air pollution, for it did little to actually prevent air pollution because it did not include a comprehensive federal response nor a specific agency to enforce the legislation. The CAA of 1963 was then passed to replace the Air Pollution Control Act, and it was followed closely by the Motor Vehicle Air Pollution Control Act of 1965. This act was the first piece of legislature to establish federal automobile emissions standards, which took effect with model year 1968. In 1970, the EPA was created to establish and enforce environmental protection standards and to conduct environmental research. The CAA was also amended in 1970 and then updated multiple times, with sweeping changes taking place in 1977 and 1990. The current version, the 1990 amendments, focuses on five main areas of concern: air quality standards, motor vehicle emissions and alternative fuels, toxic air pollutants, acid rain, and stratospheric ozone depletion.

Motor Vehicle Pollution

One of the largest contributors to air pollution, motor vehicle emissions occur from fuel combustion (carbon monoxide – CO, hydrocarbons – HC, and oxides of nitrogen – NOx) and fuel evaporation directly from the vehicle as well as indirectly from refueling and fuel production emissions. Title II of the CAA, Emission Standards for Moving Sources, addresses this sector and details what standards motor vehicles must meet to achieve compliance. Part A, Motor Vehicle Emission and Fuel Standards, sets comprehensive requirements for motor vehicles to mandate that manufacturers build cleaner engines and establishes requirements for refiners to produce new and cleaner fuels. At the same time in Title I, Part D sets specific program criteria for areas with air pollution problems including requiring vehicle inspection and maintenance programs, vapor capture at gasoline filling stations (called Stage 2 controls), on-board vapor recovery equipment, and the use of reformulated gasoline.

<u>Cleaner Engines</u>

Automobile manufacturers must produce motor vehicles with cleaner engines as a result of many requirements from the CAA. One of the first mandates was the establishment of automobile emission standards in the 1965 Motor Vehicle Air Pollution Control Act. Minimal requirements for HC and CO emissions were imposed on vehicles beginning with model year 1968. Stricter standards took effect with model year 1973 which mandated certain emissions control devices such as PCV valves and for most vehicles air pumps and catalytic converters. The early catalytic converters reduced the CO and HC emissions by oxidation. Later catalytic converters, required by most vehicles for model year 1981 according to CAA amendments in 1977, also reduced NO emissions by reduction reactions. EPA also set requirements to control gasoline evaporation from the vehicle, requiring carbon canisters to capture vapors. Emissions standards did not change until the 1990 CAA amendments, which mandated that stricter tailpipe standards be phased in by model year 1996 (Tier 1 vehicles see Appendix 5). These amendments also had provisions for EPA to set tighter standards later, which resulted in the Tier 2 emissions standards that took effect with model year 2004. In addition, evaporative emission requirements were made substantially more stringent starting with model year 1999.

Motor vehicles must now also contain equipment to monitor the performance of the pollution control equipment. The 1990 CAA Amendments required that by model year 1996, all motor vehicles must contain an on-board diagnostics (OBD) system. This device continuously monitors the engine, transmission, and emissions control systems. Whenever a malfunction occurs in any of these areas, the “check engine” light is triggered. The OBD is essentially an internal computer that inspectors can access to determine why the “check engine” light has been triggered. This system functions as an early warning system for problems, and can result in reduced pollution and even monetary savings. Many localities require OBD tests, in which the inspector simply checks to see if the “check engine” light is on or if any “diagnostic trouble codes” are present. OBD systems are now required on all vehicles less than 8500 pounds gross vehicle weight rating (GVWR). The creation of the OBD system has resulted in the design of emission control systems with significantly less deterioration over time.

Cleaner Fuels

Many efforts to produce cleaner fuels have also been pursued. One of the largest changes in fuels over the past few decades was the mandated elimination of lead from gasoline. A toxic pollutant, tetra ethyl lead was originally added to gasoline to boost octane levels in order to reduce pre-ignition (pinging). However, its toxicity and its damaging effects to automobiles and their pollution control equipment led to the progressive elimination of lead from gasoline beginning in 1973. The 1990 CAA amendments prohibited the manufacture of engines requiring leaded gasoline by January 1, 1996.

The 1990 CAA amendments also required the use of oxygenated gasoline with at least 2.7% oxygen content in several areas of the country that failed to attain the National Ambient Air Quality Standard (NAAQS) for CO. During the winter months of 1992-1993, many new oxygenated gasoline programs, including northern Virginia, were implemented to increase combustion efficiency in cold weather and thereby reduce CO emissions. The northern Virginia area has since become attainment for CO and the 2.7% winter requirement has been dropped.

Another cleaner fuel initiative is reformulated gasoline (RFG), which the CAA requires in areas with the worst ground-level ozone pollution, or nonattainment areas. Reformulated gasoline, introduced in two phases, must reduce VOCs by 17% and 27%. There are also significant NOx reductions. Among other composition requirements, RFG must not have more than 1% benzene, the most toxic component of gasoline, and must contain at least 2% oxygen by weight. This percent was originally achieved by the addition of MTBE, but ethanol is now most commonly used. The oxygenate requirement was later removed as it was determined that there was less benefit for modern engines.

The removal of sulfur from fuel is a more recent effort. Beginning in 2004, all gasoline sold must contain an average of no more than 30ppm sulfur. Sulfur was found to have a damaging (but reversible) effect on catalytic converters. Yet another program requires the virtual elimination of sulfur from diesel fuel (average not to exceed 15ppm), as sulfur is also damaging to diesel pollution control equipment. Its removal will allow diesel vehicles to have more advanced pollution control equipment and it will also greatly reduce diesel vehicle pollution.

Efforts have also been made to reduce the evaporative emissions from fuels. Stage II Pump Vapor Controls are control devices on the gasoline pumping equipment itself. These devices take the vapors normally emitted into the air and recycle them back into the fuel storage tanks. Finally, beginning in model year 1998, motor vehicles were required to have On-Board Refueling Vapor Recovery (ORVR) equipment, which captures most of the refueling vapors even without Stage II devices.

Inspection and Maintenance Programs (I/M)

The 1990 amendments of the CAA mandate that 33 states and localities implement Inspection and Maintenance (I/M) Programs. An area is required to execute an I/M program based on its air quality classification, population, geographic location, and other criteria. Some localities choose to develop an I/M program even if they are not mandated to do so. The tests associated with the I/M program aim to identify motor vehicles that emit too much pollution and need repair. Common tests include visual inspection, tailpipe emissions and evaporative system pressure testing, and the download of information from the vehicle's OBD system. Enforcement can be through stickers, fines, or registration denial, where vehicles can not receive their vehicle registration before completing the repairs.

Motor Vehicle Emission Standards and Certification

The US EPA must certify new vehicles before they can be sold in the US. Manufacturers must demonstrate that the certification emission level will be maintained for a specified lifetime, currently 100,000 miles for most passenger vehicles. Standards are set for the exhaust pollutants HC, CO, and NOx as well as evaporative HC emissions depending on vehicle type and weight. Categories include light-duty passenger vehicles, light-duty trucks, heavy-duty vehicles, and motorcycles. In recent years, however, larger vehicles that are generally higher emitters have been held to standards closer to those of the passenger cars. To measure these emissions, EPA has a test cycle that simulates on-road driving behavior known as the Federal Test Procedure (FTP). A supplemental test that takes into account more aggressive modern drivers was introduced between 2000 and 2004 (See appendix 6).

Until recently one standard was applied to all vehicles of a particular type and weight range. This process was easy for the manufacturers to comply with but had the "least common denominator" effect of providing no incentive for improvement. California took the lead with their Low Emission Vehicle (LEV) program which began in 1992. Each manufacturer had to meet an overall average emission level which got stricter each year. Vehicles in each type and weight group could be certified to one of several different categories. In addition to the existing vehicle category which, was called Tier 0, and the Tier 1 vehicle category mandated by the 1990 CAAA, the California LEV program created new environmentally friendly vehicle categories initially including Low Emission Vehicles (LEV), Ultra LEV (ULEV), and Zero Emission Vehicles (ZEV). The overall average per vehicle emissions was to gradually diminish as manufactures shifted more models to the cleaner categories and dropped dirtier categories. This concept was followed by EPA with the Tier 2 standards which took effect in 2004. EPA uses the term "bins" to refer to emissions categories that are very similar to the current California LEV-II program.

It is likely that this approach has been in part responsible for significant gains in vehicle emission control technology in the last 15 years. This approach also offers vehicle purchasers a choice to buy significantly cleaner vehicles, a choice that was previously not available.

Fuel Economy Standards

Congress established the Corporate Average Fuel Economy program better known as the CAFE program as part of the Energy Policy Conservation Act of 1975. The goals of CAFE standards were to reduce US dependence on foreign oil and decrease the consumption of gasoline. National Highway Traffic Safety Administration (NHTSA) is responsible for establishing and amending the CAFE standards. This program requires auto manufacturers selling in the United States to meet certain fuel efficiency standards and levels for their fleet of new cars and light-duty trucks (i.e., up to 8,500 lbs GVWR) comprised of pickups, minivans, and sport utility vehicles (SUVs). Passenger vehicles were defined as any 4-wheel vehicle not designed for off-road use that is manufactured primarily for use in transporting 10 people or less. Light trucks that exceed 8,500 lbs gross vehicle weight rating (GVWR) do not have to comply with CAFE standards.

The standard for passenger cars is currently 27.5 miles per gallon. Proposals to increase the fuel mileage standards for passenger vehicles are now being debated in Congress.

Congress did not specify a target for the improvement of light truck fuel economy. In Model Year (MY) 1992, fleets were required to meet a standard of 20.2 mpg. The standard progressively increased until 1996, when it froze at 20.7 mpg. In 2003, NHTSA issued new light truck standards, setting a standard of 21.0 mpg for MY 2005, 21.6 mpg for MY 2006, and 22.2 mpg for MY 2007. Overall fuel economy for both cars and light trucks in the U.S. market reached its highest level in 1987, when manufacturers managed 26.2 mpg (8.98 L/100 km). The average in 2004 was 24.6 mpg. In that time, vehicles increased in size from an average of 3,220 pounds to 4,066 lb (1,461 kg to 1,844 kg), in part due to an increase in truck ownership during that time from 28% to 53%.

The CAFE rules for trucks were officially amended in March, 2006. All SUVs and passenger vans up to 10,000 pounds GVWR now have to comply with CAFE standards, but pickup trucks and cargo vans over 8500 pounds gross vehicle weight rating (GVWR) remain exempt. Under the new final light truck CAFE standard for MY 2008-2011, fuel economy standards are restructured so that they are based on a measure of vehicle size called "footprint," the product of multiplying a vehicle's wheelbase by its track width. A target level of fuel economy is established for each increment in footprint using a continuous mathematical formula. Smaller footprint light trucks have higher fuel economy targets and larger trucks lower targets. Manufacturers who make more large trucks are allowed to meet a lower overall CAFE target, manufacturers who make more small trucks must meet a higher standard. Unlike previous CAFE standards there is no requirement for a manufacturer or the industry as a whole to meet any particular overall actual MPG target, since this will depend on the mix of sizes of trucks manufactured and ultimately purchased by consumers.

EPA performs a fuel mileage test based on a specific driving “trace” which is supposed to represent typical driver behavior. This is the fuel mileage that is used to determine both CAFE compliance and new vehicle “sticker” fuel mileage. Recently this drive trace was changed to better represent modern, more powerful vehicles. This change will affect model year 2008 vehicle sticker mileage, but will not affect existing CAFE rule compliance.

Non-Federal Emissions Programs

California Efforts

Many of the federal regulations implemented by the EPA were preceded by laws passed in California. California passed its original Air Pollution Control Act in 1947, which was 8 years before the Federal Air Pollution Control Act of 1955. The state had air quality standards before the federal National Ambient Air Quality Standards (NAAQS) were instituted. The California Air Resources Board (ARB) was established three years before the federal EPA. Because of this history and because of California’s more extreme air pollution problems, the CAA allowed California to uniquely set its own vehicle emissions standards. Other states were allowed the option of opting into the California standards.

The California emissions standards have been consistently more stringent than the federal standards. Also, California has taken the lead on many new technical and enforcement innovations. Overall, California’s efforts have preceded the national efforts, are generally more stringent, and in many cases provided a model for federal legislation.

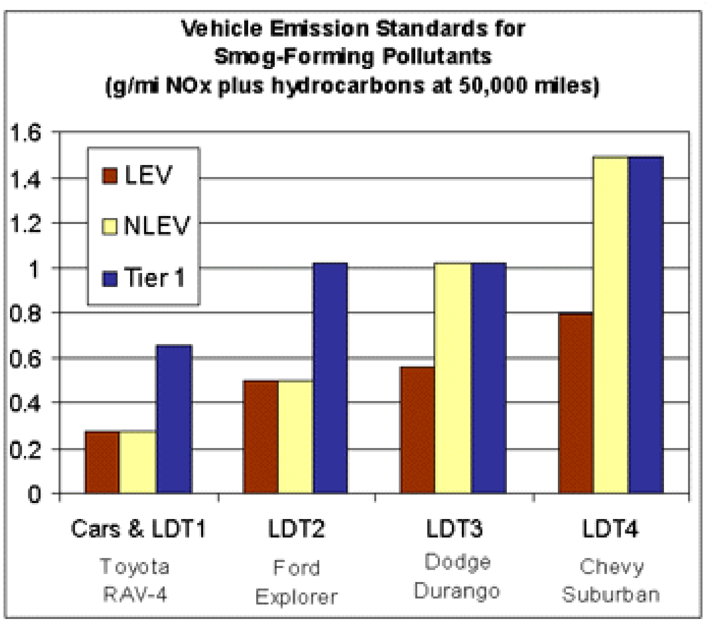
California’s current non-mandatory programs provide a glimpse of possible federal motor vehicle legislation to come. For example, the Voluntary Accelerated Vehicle Retirement (VAVR) program encourages and pays owners of older higher-emitting vehicles to retire the vehicles in exchange for a newer, lower-emitting vehicle. The Mobile Source Emission Reduction Credits program gives credits to vehicles that have fewer emissions than the mandated standards. The Alternative Fuels Incentive Program encourages the use of alternative fuels. These programs and more exemplify California's voluntary efforts to reduce air pollution and increase air quality.

Efforts by Other States

States generally have the option to follow either the federal requirements or the more stringent California requirements. Many states and localities have also elected to participate in programs that are not mandated, such as I/M programs and the use of reformulated gasoline or other specialized motor vehicle fuels.

One group of states, NESCAUM, for Northeastern State Air Use Management, was founded in 1967 and has grown to address the entire spectrum or air quality issues including diesel exhaust, climate change, energy efficiency, and cleaner cars and fuels. NESCAUM was a key player in the decision of many New England states to adopt the California LEV program in the 1990s. They continue to provide research resources and guidance in mobile source issues.

Another state group is the Ozone Transport Commission which is multi-state organization created by the 1990 CAA and is comprised of 13 states from Virginia to Maine (states in the "Ozone Transport Region" or OTR). The OTC was instrumental in orchestrating an agreement with the major automobile manufacturers wherein they would voluntarily supply certain California LEV vehicles to OTR states starting in model year 1999 and other states in 2001, in lieu of many of the OTR states adopting the full California LEV program. This program is known as National Low Emission Vehicle or NLEV. A comparison of the Tier 1 standards, the NLEV standards and the CA LEV I standards for four example vehicles is shown in the following table.



Aim of these regulations

Reduce air pollution

Motor vehicle regulations are driven by the need to meet the National Ambient Air Quality Standards (NAAQS) and to reduce the mobile source contribution to air pollution nonattainment areas. In most cases, the driving standard was ozone attainment, although the CO standard was the driver in some areas. Thus the standards have used a variety of approaches to reduce CO, HC, or NOx emissions, the latter two of which are precursors to ozone formation. Primary reasons for air pollution reductions include its adverse impact on health and the environment. GHG emissions have been dealt with to the extent that fuel efficiency has been addressed by the regulations. The regulations also had the benefit of reducing the reliance on foreign oil.

Health Impacts

Air pollutants from motor vehicles include particulate matter, ozone, carbon monoxide, nitrogen dioxide, and other toxic air contaminants. All of these pollutants can cause lung irritation, asthma, and circulatory diseases. More extreme effects include those of particulate matter, which can increase respiratory disease and even premature death. Carbon monoxide can cause chest pain, headaches, nausea, reduced mental alertness, and death. Other toxic air contaminants can result in cancer, chronic eye, lung, or skin irritation, or neurological and reproductive disorders. In even small amounts, these air pollutants from motor vehicles can cause very dramatic and damaging health problems. For further information regarding the health impacts of air pollutants, refer to the 2006 project report entitled: "Outdoor Air Pollution, Health and Health Costs in Virginia," written by Dudley F. Rochester, M.D. (see References section).

Environmental Impacts

Motor vehicle air pollution also contributes to the damaging of the environment. Air pollutants play a role in the formation of smog, the deterioration of the ozone layer, and the formation of acid rain. Ground-level ozone, a secondary pollutant created by other pollutants directly emitted from motor vehicles, is very harmful to trees, crops, and wildlife.

Emissions from motor vehicles also contribute to water degradation. For example, nitrate deposition originating from motor vehicle exhaust is a significant contributor to nitrification of Chesapeake Bay. Also, additives such as MTBE from gasoline spills, and to a lesser extent from exhaust, can degrade drinking water quality.

Growing bodies of research also suggest that certain air pollutants contribute to the phenomenon called global warming. These air pollutants, called greenhouse gases, include nitrogen oxides, ozone, and carbon dioxide.

Reduce effects of urban sprawl

Urban sprawl is associated with a number of negative environmental and public health outcomes. The primary cause of these negative outcomes is that sprawl leads to people having to depend on the automobile because it will be a greater distance to travel and people will not be able to walk or ride their bicycles to their destinations. Living in a larger, more spread out space makes public services more expensive. Car usage often becomes endemic and public transport often becomes significantly more expensive.

Reduce reliance on foreign oil

For political, security, and economic issues, it has become increasingly important to reduce the nation's reliance on foreign oil. The more stringent motor vehicle fuel economy requirements begin to reduce this reliance on foreign oil. "Most of the world's oil is concentrated in places that are either hostile to American interests or vulnerable to political upheaval and terrorism," said Richard G. Lugar (R-IN), Chairman of the Senate Foreign Relations Committee. "To the extent that we remain reliant on imported oil, we imperil our nation's economic health and our way of life."

Most studies estimate that oil production will peak sometime between now and 2040, although many of these projections cover a wide range of time, including two studies for which the range extends into the next century. The timing of the peak depends on multiple, uncertain factors that will influence how quickly the remaining oil is used, including the amount of oil still in the ground, how much of the remaining oil can be ultimately produced, and future oil demand.

> Other important sources of uncertainty about future oil production are potentially unfavorable political and investment conditions in countries where oil is located. For example, more than 60 percent of world oil reserves, on the basis of Oil and Gas Journal estimates, are in countries where relatively unstable political conditions could constrain oil exploration and production. Future world demand for oil also is uncertain because it depends on economic growth and government policies throughout the world.

Discussion of how GHG emission issue has evolved

As has been described above, motor vehicle emissions have been regulated to reduce ozone pollution, carbon monoxide pollution and to some extent toxic emissions. More recently, however, of motor vehicles' contribution to greenhouse gases and their climate change and other environmental impacts has become an issue. Greenhouse gases emitted by motor vehicles include carbon dioxide, nitrogen oxides, and carbon monxide as well as refrigerant from air conditioners. The transportation sector made up 27 percent of the total U.S. greenhouse gas emissions in 2003. The transportation sector is also the largest end-use source of carbon dioxide, which is the most prevalent greenhouse gas. From 1990 to 2003, the carbon dioxide emissions in transportation increased by 24%; the increase in all other sectors combined was only 9.5% ("GHG Emissions from the U.S. Transportation Sector: 1990-2003", 2006). This rapid increase has resulted in more focus on motor vehicles as large contributors to greenhouse gases and their influence on global warming and climate change.

Recently California adopted regulations as part of the LEV program that will regulate greenhouse gas emissions from motor vehicles certified in California. These regulations are slated to take effect with model year 2009. Although California has had the option of setting its own standards since the beginning of the CAA (and other states have had the option of adopting the California standards), this action was at first challenged on the grounds that regulating CO2 was in effect the same as regulating fuel mileage and that it was the US Department of Transportation which had sole responsibility in setting mileage (i.e., CAFE) standards. Recently, however, the US Supreme Court ruled that EPA did have the authority to regulate CO2 as a pollutant and therefore so did California.

III. Standards

Fuel Standards Overview

Vehicle Fuel Formulation Standards

Emissions from vehicle fuels are part of the reason for the variation of fuels marketed in different parts of the country. By the spring of 2007, there were 15 different gasoline formulations required across the country. **(See Appendix 9 plus abbreviations)** While these various fuels mixtures are based on location and air pollution reduction efforts, the result can be a “patchwork” of boutique fuels. The term “boutique fuels” refers to the various specialized gasoline formulations made to meet air quality standards or local preferences. Because requirements can vary from state to state, and within a state, if there is a disruption in fuel supply, it may be difficult for refiners to supply fuel meeting local specifications to the affected areas.

Fortunately in Virginia, we have requirements for only two major specifications for fuels. Reformulated gasoline (RFG) is based on a federal program which aims to reduce emissions of toxic air pollutants and ozone forming compounds. Conventional fuel is a more standard fuel and sold across most of the country. **(See RFG map attached Appendix 1**). The RFG fuels are required to be sold year-round in most of Northern Virginia, Hampton Roads and the Greater Richmond area. As of May of 2006, those fuels were blended with a mixture of approximately 10% ethanol [1] which contributes to meeting the nation’s Renewable Fuels Standard (RFS). The RFS requires the use of 7.5 billion gallons of renewable fuel in gasoline by 2012. Conventional fuels are sold in all the rest of the areas of the Commonwealth. On a Virginia map, conventional fuels cover a larger geographic territory. However, it is safe to say that most of the fuel sold in Virginia is RFG since the major population regions of the state require it. And while these two types of fuels are the only ones required, there are additional requirements for summertime and wintertime blends of these fuels due to the volatility of gasoline. This evaporative nature is measured by the Reid Vapor Pressure (RVP) standard and Virginia regulations set forth different levels of RVP which must be in fuels for different months of the year. The RVP level standard for both conventional and RFG fuels must be lower in late spring through early fall months as directed by Virginia regulations. Also, because gasoline blended with 10% ethanol has a higher volatility, the RVP limit is raised by 1 psi. This has become referred to as the “one pound waiver” for ethanol blends.

The “drivers” of the fuels described above are clean air laws on both the federal, state and local level. Virginia coordinates its clean air laws to align with the federal requirements. The requirements for the most part center on the reduction of ozone. Gasoline vapors from fuels, motor vehicle exhaust and industrial emissions, chemical solvents as well as natural sources emit NOx and VOC’s that help form ozone. Ground-level ozone is the primary constituent of smog and sunlight and hot weather cause ground-level ozone to form in harmful concentrations in the air. To protect public health and welfare, EPA issues National Ambient Air Quality Standards (NAAQS) for six criteria pollutants and ground-level ozone is one of these. EPA first issued standards for ground-level ozone in 1971; and revised the standard in 1979 and 1997. Virginia has had areas classified as non-attainment through this program primarily in the Northern Virginia, Hampton Roads, and the greater Richmond area. In the spring of 2007, EPA declared that the Hampton Roads and the Richmond area were in attainment status under the 8-hour ozone monitoring standard. This ruling has little to no effect on the fuels distribution arrangement in Virginia however as those areas newly declared in attainment must still provide the RFG fuels as part of the maintenance plan to keep the areas in attainment. Currently the 8-hour standard of 0.085 parts per million (ppm) is the level triggers a violation of the standard (In practice, because of rounding, an area meets the standard if ozone levels are 0.084 ppm or lower.) Some scientists and advocates have argued that levels below this are still creating health concerns and so in June 2007, the Environmental Protection Agency proposed to revise the 1997 standards to set the primary health standard to a level within the range of 0.070-0.075 ppm. The Agency is also requesting comments on alternative levels of the

[1] Ethanol in the U.S. is primarily derived from corn and has been used for a number of years as a gasoline extender and booster of octane.

8-hour primary ozone standard, within a range from 0.060 ppm up to and including retention of the current standard of 0.084 ppm. While the final determination of what the revised standards will be will not be known until March of 2008, the areas recently declared as attainment could very well be listed back to non-attainment under any measuring standards below those required now.

Diesel Fuel Standards

While diesel fuel across the nation and Virginia is more uniform in distribution and availability, there are new standards also driven by air pollution reduction and federal clean air laws which reduce the sulfur content in diesel fuel. This Ultra-Low Sulfur Diesel (ULSD) program [2] is aimed at reducing the sulfur content in fuel from over 500 parts per million (PPM) to15 ppm. The phase in for this program began in October of 2006. Unlike the RFG gasoline program, there is no federal geographic requirement for these fuels. Rather, at least 80% of all on- road diesel fuel sold must be ULSD during October 2006 through 2009, and 100% must be ULSD by 2010. Off road diesel for farm and construction use must be all USLD by 2010. This phased in approach over a number of years and the avoidance of prescribing specific regions and states where such fuels shall be sold has made the transition to ULSD fuel much more manageable and efficient for the petroleum industry and less disruptive and less costly to consumers.

Biodiesel, Ethanol, and Flex Fuel Vehicles

Biodiesel fuels[1] have more flexibility in that they can generally be used in any diesel engine. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines with little or no modifications. It is usually made from soy or canola oil, and can also be made from recycled fryer oil. You can blend biodiesel with regular diesel or run 100% biodiesel, however for most vehicles the blend used is at a rate between 2 and 20 percent. This is done because pure biodiesel has a higher gel point. B100 (100% biodiesel) and gets slushy a little under 32°F. But B20 (20% biodiesel, 80% regular diesel - more commonly available than B100) has a gel point of -15°F. Like regular diesel, the gel point can be lowered further with additives such as kerosene (blended into winter diesel in cold-weather areas). Old vehicles (older than mid-90s) might require upgrades of fuel lines (a cheap, easy upgrade), as biodiesel can eat through certain types of rubber. More information on biodiesel is available from the report produced by the State Air Pollution Advisory Board in 2006 and presented to the State Air Pollution Control Board at it’s meeting in December of 2006.

In addition to the ethanol blend fuels that constitute the RFG described earlier in this section, some states are encouraging or mandating the use of ethanol blends, E-85 (15% gasoline and 85% ethanol) and biodiesel fuels as well. In Virginia, the Energy Policy Act of 2006 “promotes the use of biodiesel and ethanol produced from agricultural crops grown in the Commonwealth”. Also, Executive Order 48 issued by Governor Kaine on April 5, 2007 includes the following:

All agencies and institutions shall maximize biodiesel and ethanol use in state fleet vehicles except where use of biodiesel will void warranties or incur unreasonable additional costs to the agencies. The Department of General Services shall make available, at selected sites based upon the locations of state-owned flex-fuel and diesel vehicles, E85 and B20 fuels for agencies. Agencies and institutions that independently purchase fuel shall use E85 and B20 fuel sites to the maximum extent reasonably possible.

E85 cannot be used in a conventional, gasoline only vehicle. The vehicles have to be built or equipped to be “flex-fuel” vehicles (FFV) which can run on either E85 or regular fuels. Also, the fuel is only available at specific E85 pumps so the motoring public will not become confused and pump

[1] In the US, soybean oil is the primary feedstock but vegetable oil, animal fat or waste cooking oil can be used after being subjected to proper refining. While a 100% biodiesel can be burned in some engines, it is not very compatible with most existing diesel engines or boilers. It is much more common to see blends from 2% up to 20%.

E85 into a conventional gas car. This can lead to a whole range of problems, including not being able to start the engine, damage to the engine components, illumination of the check engine light, and emissions increases. Manufacturers have announced plans to expand the number of FFV's models they will offer. At the end of 2006, about 6 million FFV's were on the road in the US. E85 provides important reductions in greenhouse gas emissions and replaces gasoline. The downside is that it reduces fuel economy by about 20-30 percent meaning FFV's will travel fewer miles on a tank of E85 than on a tank of gasoline.

It's important to keep in mind that biodiesel and ethanol fuels be purchased from an environmentally reputable source/company due to the concern of food crop limitation resulting in potential widespread hunger.

Vapor Capture & Reduction

While a primary control on emissions from fuel is the formula and specific mixture or blend of the fuel itself, there are also controls that seek to capture and reduce the vapors from fuels as another way to reduce overall emissions. A transition is underway which started back in 1990 when the Clean Air Act Amendments of 1990 required passenger vehicles to recapture refueling emissions (onboard canisters) while at the same time, vapors from gasoline pumps nozzles were required to be captured in the higher end non-attainment areas listed at the time. (Stage II). Those programs ran parallel to each other and still do but Stage II controls are gradually becoming obsolete. All passenger cars had to have onboard canisters by the 2000 model year and all light duty trucks had to have the same as of 2006. Since the two systems accomplish the same thing (that is, capture fuel vapors as the vehicle is being refueled), the Stage II program is seen as a redundant system and as more older model cars are no longer driven, the need for Stage II controls is even less. At some date in the near future, and it could be just a matter of a few years, EPA may declare that on board canisters are in "widespread use" based of the number of later model cars on the road. When that is official, the Clean Air Act authorizes states to phase out Stage II programs, even in the worst nonattainment areas. In Virginia, only the greater Richmond area and the Northern Virginia non-attainment areas are required to have Stage II pumps and they have been in place at most* refueling locations there since the early 1990's (* there are exceptions in regulations for Stage II which exempt certain low volume stations and some localities not in the original non-attainment areas.)

(See Appendices 2 and 3 for maps noting locations in Virginia where biodiesel and E85 fuels are available.)

The above discussion makes it clear that the current system of gasoline, diesel and alternative fuels standards is complex. These various fuel formulations are often referred to as "boutique fuels" State and local decisions can sometimes overlap with federal requirements and then adjacent or nearby areas may have significantly different requirements. These various fuel formulations can lead to shortages and price spikes if an area facing supply disruptions cannot import available fuel from a nearby zone because it is a different formulation. There are benefits in simplifying the system so that regional or national standards are consistent.

Emissions Standards Overview

Federal Tier 2 Light-duty Vehicle Standards

EPA introduced the Tier 2 emissions standards starting with model year 2004 and concurrently with low sulfur fuel requirements which were necessary for advanced emission controls to function effectively. The Tier 2 regulation introduced more stringent numerical emission limits relative to the previous Tier 1 requirements, and a number of additional changes that made the standards more stringent for larger vehicles. Under the Tier 2 regulation, the same emission standards apply to all vehicle weight categories, i.e., cars, minivans, light-duty trucks, and SUVs have the same emission limit.

In Tier 2, the applicability of light-duty emission standards has been extended to cover some of the heavier vehicle categories. The Tier 1 standards applied to vehicles up to 8500 lbs GVWR.

The Tier 2 standards apply to all vehicles that were covered by Tier 1 and, additionally, to "medium-duty passenger vehicles" (MDPV). The MDPV is a new class of vehicles that are rated between 8,500 and 10,000 lbs GVWR and are used for personal transportation. This category includes primarily larger SUVs and passenger vans. Engines in commercial vehicles above 8500 lbs GVWR, such as cargo vans or light trucks, continued to certify to heavy-duty engine emission standards.

The same emission limits apply to all vehicles regardless of the fuel they use. That is, vehicles fueled by gasoline, diesel, or alternative fuels all must meet the same standards. Since light-duty emission standards are expressed in grams of pollutants per mile, vehicles with large engines (such light trucks or SUVs) have to use more advanced emission control technologies than vehicles with smaller engines in order to meet the standards.

The Tier 2 emission standards are structured into 8 permanent and 3 temporary certification levels of different stringency, called "certification bins", and an average fleet standard for NO_x emissions. (See Appendix 6) Vehicle manufacturers have a choice to certify particular vehicles to any of the available bins. When fully implemented in 2009, the average NO_x emissions of the entire light-duty vehicle fleet sold by each manufacturer has to meet the average NO_x standard of 0.07 g/mi. The temporary certification bins (bin 9, 10, and an MDPV bin 11) with more relaxed emission limits are available in the phase-in period and expire after the 2008 model year, The EPA bins cover California LEV II emission categories, to make certification to the federal and California standards easier for vehicle manufacturers.

The vehicle "full useful life" period for LDVs and light LDTs has been extended to 120,000 miles or ten years whichever occurs first. For heavy LDTs and MDPVs, it is 11 years or 120,000 miles whichever occurs first. Manufacturers may elect to optionally certify to the Tier 2 exhaust emission standards for 150,000 miles to gain NO_x credits or to opt out of intermediate life standards.

The Tier 2 standards are phased-in between 2004 and 2009. For new passenger cars (LDVs) and LLDTs, Tier 2 standards phase-in begins in 2004, with full implementation in the 2007 model year. For HLDTs and MDPVs, the Tier 2 standards are phased in beginning in 2008, with full compliance in 2009.

Federal Standards for "Heavy-duty" Vehicles

Although EPA defines Heavy-duty vehicles as vehicles with a GVWR (gross vehicle weight rating) of above 8,500 lbs in the federal jurisdictions, California (for model year 1995 and later) defines vehicles as Medium-duty vehicles from 8,500 GVWR to 14,000 lbs. Current federal regulations do not require that complete heavy-duty diesel vehicles be chassis certified, instead requiring certification of their engines (as an option, complete heavy-duty diesel vehicles under 14,000 lbs can be chassis certified). Consequently, the basic standards are expressed in grams per brake horsepower-hour (g/bhp·hr) and require emission testing over the Transient FTP engine dynamometer cycle. However, chassis certification may be required for complete heavy-duty gasoline vehicles with pertinent emission standards expressed in g/mile.

Under the federal light-duty Tier 2 regulation vehicles of GVWR up to 10,000 lbs used for personal transportation have been re-classified as "medium-duty passenger vehicles" (MDPV - primarily larger SUVs and passenger vans) and are subject to the light-duty vehicle standards. Therefore, the same diesel engine model used for the 8,500 - 10,000 lbs vehicle category may be classified as either light- or heavy-duty and certified to different standards, depending on the application.

Emissions standards did not change appreciably from MY 1988 until MY 1998 when they were set to:

- PM --- 0.10 g/bhp-hr.

- NOx --- 4.0 g/bhp-hr.
- HC -- 1.3 g/bhp-hr.

Interim standards applied to vehicles from MY 1999 with the goal of reducing heavy-duty NOx to level near 2.0 g/bhp-hr.

In 2000 EPA signed emission standards for model year 2007 and later heavy-duty highway engines (the California ARB adopted virtually identical 2007 heavy-duty engine standards in 2001). The rule includes two components: (1) emission standards, and (2) diesel fuel regulation.

The first component of the regulation introduces new, very stringent emission standards, as follows:

- PM—0.01 g/bhp-hr
- NOx—0.20 g/bhp-hr
- NMHC—0.14 g/bhp-hr

The PM emission standard will take full effect in the 2007 heavy-duty engine model year. The NO_x and NMHC standards will be phased in for diesel engines between 2007 and 2010. The phase-in would be on a percent-of-sales basis: 50% from 2007 to 2009 and 100% in 2010 (gasoline engines are subject to these standards based on a phase-in requiring 50% compliance in 2008 and 100% compliance in 2009)

Ultra low sulfur diesel fuel at 15 ppm sulfur was introduced in fall of 2006 as a “technology enabler” to pave the way for advanced, sulfur-intolerant exhaust emission control technologies, such as catalytic diesel particulate filters and NO_x catalysts, which are necessary to meet the 2007 emission standards.

Evaporative Emissions Standards

A substantial amount of motor vehicle emissions occurs from fuel evaporation, both from the vehicle and from refueling. Evaporative emissions from the vehicle occur largely due to displacement of these vapors during refueling, temperature variation pressures on the vapor space in the fuel tank (called diurnal cycles), and to a lesser extent fuel line permeation. Evaporative emissions standards were substantially strengthened by EPA beginning with model year 1999. This included a new testing protocol whereby diurnal emissions are measured over a 5-day “soak” as opposed to the one day test used previously.

The 1990 CAAA required Stage II refueling vapor recovery devices in all moderate and worse ozone nonattainment areas, including the northern Virginia and Richmond areas. On-board Refueling Vapor Recovery (ORVR) equipment was phase in from 1998 (40%) through 2000 (100%) for light-duty vehicles and medium duty trucks (to 8500 lbs GVWR) by model year 2006. Heavy duty (over 8500 lbs GVWR) will have ORVR equipment later. EPA “may by rule” waive Stage II requirements when ORVR are in widespread use. However, the Ozone Transport Region, which includes northern Virginia, is required to maintain Stage II controls or equivalent. Possible enhancements to or in lieu of Stage II include “dripless” nozzles, storage tank pressure units, and in-station diagnostic units.

The Tier 2 standards will reduce new vehicle NOX levels to an average of 0.07 grams per mile (g/mi). The reductions in non-methane orgnic gases (NMOG) vary depending on the mix of emission standard “bins” chosen by the manufacturer to meet the NOx average.

California LEV II Standards

The LEV II standards are a continuation of the California LEV program begun in 1992. Under the LEV II regulation, the light-duty truck and medium-duty vehicle categories of below 8500 lbs GVWR were reclassified and have to meet passenger car requirements, as shown. As a result, most pick-up trucks and sport utility vehicles are required to meet the passenger car emission standards. This reclassification was fully phased-in by the year 2007. Increased emission control durability standards from 100,000 miles to 120,000 miles for passenger cars and light trucks

Under the LEV II standard, NOx and PM standards for all emission categories are significantly tightened. The same standards apply to both gasoline and diesel vehicles and gasoline vehicles are no longer exempted from the PM standard. Light-duty LEVs and ULEVs must certify to a 0.05 g/mi NOx standard, phased-in starting with the 2004 model year. A full useful life PM standard of 0.010 g/mi is introduced for light-duty diesel vehicles and trucks less than 8500 lbs GVWR certifying to LEV, ULEV, and SULEV standards. The TLEV emission category (same as the Federal Tier 1 vehicle) has been eliminated. The LEV II emission standards can only be met by vehicles fitted with advanced emission control technologies, such as for diesel vehicles, particulate filters and NOx reduction catalysts. LEV II also created a new super-ultra low emission vehicle (SULEV) category for light-duty vehicles. SULEV's only emit a single pound of hydrocarbons during 100,000 miles of driving,-about the same as spilling a pint of gasoline.

The LEV II standards also made provisions for creation of partial zero-emission vehicle (ZEV) credits for vehicles that achieve near zero emissions. The credits include full ZEV credit for a stored hydrogen fuel cell vehicle, 0.7 credit for methanol reformer fuel cell vehicles, 0.4 credit for a compressed natural gas SULEV and 0.2 for a gasoline fueled SULEV. This concept was extended to include advanced technology such as hybrid-electric vehicles, many of which are able to achieve partial ZEV certification. A useful life of 150,000 miles must be demonstrated for PZEV status;

The LEV II standards also include an extension and tightening of the fleet average standards requiring automakers to reduce fleet emission levels each year through 2010 as well as tightening of evaporative emission standards.

The LEV II standards for Light-duty and Medium-duty vehicles are shown in Appendix 8.

California Greenhouse Gas (GHG) Standards

Much of the technological advances in motor vehicles have been directed at improving ozone forming emissions and engine performance in terms of power output.

In 2003 California passed General Assembly Bill 1493 aimed at reducing GHG emissions from motor vehicles and required the California Air Resources Board (CARB) to adopt regulations by 2005 that will achieve the maximum achievable reduction of GHG emissions in a cost effective manner from light-duty vehicles beginning with model year 2009. The regulations were to address CO_2, CH_4, N_20 and HFC emissions. The regulation was developed by the CA Air Resources Board in 2004, and became effective January 2006.

The standards will phase-in over the period of 2009 to 2016, as shown below. The average reduction of greenhouse gases from new California cars and light trucks will be about 22% in 2012 and about 30% in 2016, compared to model year 2004 vehicles.

California Fleet Average GHG Emission Standards					
Time Frame	**Year**	**GHG Standard, g CO_2/mi (g CO_2/km)**		**CAFE Equivalent, mpg (l/100 km)**	
		PC/LDT1	**LDT2**	**PC/LDT1**	**LDT2**
Near Term	2009	323 (201)	439 (274)	27.6 (8.52)	20.3 (11.59)
	2010	301 (188)	420 (262)	29.6 (7.95)	21.2 (11.10)
	2011	267 (166)	390 (243)	33.3 (7.06)	22.8 (10.32)
	2012	233 (145)	361 (225)	38.2 (6.16)	24.7 (9.52)
Medium Term	2013	227 (142)	355 (221)	39.2 (6.00)	25.1 (9.37)
	2014	222 (138)	350 (218)	40.1 (5.87)	25.4 (9.26)
	2015	213 (133)	341 (213)	41.8 (5.63)	26.1 (9.01)
	2016	205 (128)	332 (207)	43.4 (5.42)	26.8 (8.78)

The GHG standards are incorporated into the California low emission vehicle (LEV) legislation. There are two fleet average GHG requirements: (1) for passenger car/light-duty truck 1 (PC/LDT1) category, which includes all passenger cars and light-duty trucks below 3,750 lbs equivalent test weight (ETW); and (2) for light-duty truck 2 (LDT2) category, including light trucks between 3,751 lbs ETW and 8,500 lbs gross vehicle weight (GVW). In addition, medium-duty passenger vehicles (MDPVs) from 8,500 to 10,000 lbs GVW are included in the LDT2 category for GHG emission standards.

The GHG standards are defined in grams per mile of CO_2-equivalent emissions (g CO_2/mi in Table 1), calculated from the following formula:

$$CO_2\text{-Equivalent} = CO_2 + 296 \times N_2O + 23 \times CH_4 - \text{AC Allowances}$$

A manufacturer may use N_2O = 0.006 g/mi in lieu of measuring N_2O exhaust emissions. The AC emission allowances are determined based on the design of the air conditioning system (with higher allowances for more leak-free and energy-efficient systems). Two sets of CO_2 values are determined: (1) city values measured over the FTP test, and (2) highway values over the EPA Highway Fuel Economy Cycle (HWFET) cycle. In the calculation of average emission for a manufacturer, the city values are taken with a weight factor of 55%, and the highway values with a weight of 45%. Additional adjustment factors and special methods are used for calculation in vehicles fueled by alternative fuels and in ZEV vehicles.

The regulation also includes GHG emission credits for manufacturers who have emissions below the standards. Credits can be earned for reductions in GHG emissions achieved in model years 2000-2008 (i.e., prior to the date the regulation becomes effective) and during the phase-in period. Accumulated credits can be used to offset compliance shortfalls up to one year after the end of the phase-in at full value, or in the second and third years after the end of the phase-in at a discounted rate.

The California GHG emission standards have been challenged in court by the automobile industry on the basis that they are a veiled form of fuel economy regulation, and only the federal government has the authority to regulate fuel economy under the CAFE legislation. California lawmakers have been arguing that they regulate vehicle emissions—as permitted under the Clean Air Act—not fuel economy.

Emissions Inspection & Maintenance (I/M) Programs

Inspection and maintenance (I/M) programs have been instituted in many jurisdictions to ensure that emission controls operate properly throughout the life of a vehicle. These programs are generally implemented in areas violating federal air-quality standards (nonattainment areas) and in other areas seeking to improve air quality.

Most I/M programs have focused on light- or medium-duty gasoline powered vehicles because this was the largest vehicle group and testing diesels required different equipment. Also, early programs focused on HC and CO reductions, which are relatively low in diesel engines. Diesel emissions inspection will be discussed further in the next section Regulatory Options.

I/M programs focus primarily on identification, diagnosis, and repair of the highest-emitting vehicles along with verification of those repairs. A number of testing or identification regimes can identify high-emitting vehicles, including traditional I/M programs testing all vehicles, programs targeting certain vehicles for more or less frequent testing, and remote sensing.

Although states have some discretion in the design of an I/M program, EPA sets minimum requirements depending on the degree of ozone nonattainment. Serious ozone nonattainment areas such as northern Virginia must have an “enhanced” I/M program which is defined by an EPA “performance standard.”

Testing options vary in price and complexity. The idle test, sometimes called “basic” I/M, measures tailpipe concentrations at curb idle. A variation is to measure emissions at curb idle and 2500 rpm. One problem with the idle test is that it cannot accurately measure NOx emissions, which occur mainly under loaded engine conditions. A more robust but more expensive test is the acceleration simulation mode (ASM) test which measures tailpipe concentration under loaded conditions using a chassis dynamometer. The ASM test can more accurately measure NOx as well as both HC and CO. An even more accurate emissions test is the IM240 test, developed by EPA. It measures “mass emissions” (in terms of grams per mile) as opposed to tailpipe concentrations, under a loaded transient drive trace which simulates normal driving. IM240 test results can more easily be correlated to actual on-road emissions reduction. Emission reductions achieved from the ASM test cannot be interpreted as a corresponding reduction in on-road emissions, at least for an individual vehicle. However, both the idle and ASM tests do an excellent job of identifying vehicles that need repairs. EPA models give the most reduction credit to the IM240 test and the least to the idle test. Virginia uses the ASM-2 or two mode ASM test.

Tailpipe test standards or “cutpoints” are designed to identify “excess emissions” which are defined as repairable emissions above the vehicles certification level. Thus, the cutpoints are more stringent for newer vehicles and less stringent for older vehicles.

In addition to exhaust emissions testing, I/M programs can test evaporative emissions. The simplest is the gas cap pressure test. EPA developed an evaporative system pressure test and a purge test which are more effective, but have had problems in implementation. Virginia uses the gas cap pressure test.

More recently I/M programs have implemented the OBD test, which applies to gasoline powered light-duty (up to 8500 lbs. GVWR) vehicles 1996 and newer and light-duty diesel vehicles 1997 and newer. The OBD test takes only a few minutes but achieves the greatest emissions reduction credit. The OBD system queries up to 12 monitors which detect faults in a variety of emissions related components. If a failure is detected that could lead to emissions exceeding 150% of the certification level, a fault code is saved and a “check engine” light is illuminated. The OBD test can identify emission component problems sometimes before they become emissions problems. OBD systems also monitor the evaporative emissions control systems. Virginia implemented the OBD test in fall of 2005.

Some studies have found that some I/M programs have achieved less emissions reductions than originally projected by EPA’s Mobile Source Emissions Factor (MOBILE 6) model and the California Air Resources Board Emissions Factor (EMFAC) model. However, a 2002 study using remote sensing data in Virginia showed that the Virginia I/M program had emissions reduction greater than that predicted by the EPA model. A new EPA model, MOVES, is now under development. It will be a “data-driven” model rather than using theoretical calculations to estimate emission factors, as with previous models. In any case, advances in vehicle longevity, spurred by OBD technology, has resulted in decreased deterioration of emissions, even though vehicles are remaining on the road longer and longer. In other words, the rate of vehicle emissions increase as vehicles get older is not as severe.

As I/M programs generally work to minimize deterioration, their benefit will tend to decrease for newer vehicles.

Despite the potential for decreasing benefits from I/M programs, it is still believed that there is a great need for programs that repair or eliminate high-emissions vehicles (commonly called high-emitting vehicles or high emitters) from the fleet, given the major influence of this small fraction of the fleet on total emissions and air quality.

Emissions reductions are skewed. The relatively small share of the vehicles which fail an I/M test can contribute a large proportion of total excess emissions (emissions above the standard for failing a vehicle), while vehicles with emissions just above the threshold for test failure (so-called “marginal emitters”) often have only a small reduction in overall emissions after repairs. This effect is exacerbated with the OBD test which detects faults in the emission control system sometimes before emissions are affected. For areas with less severe air pollution, I/M programs could be designed to focus on only the worst players. However, more needs to be known about the cost-effectiveness of setting different emissions “cut points”, including the value of repairing vehicles with emissions only marginally higher than current cut points.

The focus on reducing high-emitting vehicles should extend to promoting policies that seek effective repair or removal of all such vehicles. However, any program designed to repair high-emitting vehicles might raise serious fairness concerns, because high emitters are more likely to be owned by persons of limited economic means. Virginia law allows for a waiver, allowing registration renewal, if a minimum amount is spent on emissions related repairs, currently $680. About 1.5% of the failing vehicles in Virginia get a waiver. Some states require a minimum percent reduction in emissions to qualify for a waiver, and some argue that no waivers should be allowed – that it would be more cost effective to scrap these vehicles. Financial assistance or other incentives for motorists of high-emitting vehicles to seek repairs or vehicle replacement can be effective. It can be difficult to design the means to reduce high emitters in ways that are effective as well as socially and politically acceptable.

In summary, I&M programs should be determined on an area-specific basis and with built in flexibility to balance the relative impacts of all potential implementation requirements against their effectiveness.

IV. Discussion of the Viability of Available Regulatory Options

Enhancement of Virginia's Existing I/M Program

Currently about 80% of the vehicles in the I/M program receive an OBD test. EPA regulations allow for vehicles up to model year 2000 to pass the OBD test even though as many as two monitors are in a "not ready" state. Vehicles 2001 and newer may have one monitor not ready. There is some evidence that eliminating or modifying this readiness exemption can capture significant excess emissions. For example, a catalyst monitor not ready could mask a failed catalytic converter. DEQ could implement this through a regulation change.

The 20% of the vehicles (pre 1996) which receive a tailpipe test still produce the majority of the excess emissions. Although it is possible to tighten the cutpoints of the tailpipe test for these vehicles, EPA would not give extra credit because EPA would maintain that the increased failures could not be verified as excess emissions. However, there is evidence that older vehicles' emissions deteriorate sooner, especially after being repaired due to an I/M test failure. There would be a significant benefit to requiring pre 1996 vehicles to be tested annually. This change would have to be approved by the VA General Assembly.

Expansion of Virginia's Existing I/M Program Area

Virginia DEQ currently operates a vehicle emissions inspection program in the northern Virginia area that includes the cities of Alexandria and the counties of Arlington, Fairfax, Loudoun, Prince William, and Stafford with their inclusive cities. Substantial growth in Fauquier and Spotsylvania Counties will contribute to ozone nonattainment in northern Virginia. Expansion of the I/M program to these areas and to Fredericksburg City would be relatively easy administratively. However, adding new inspection stations could be problematic. Requiring new equipment for a diminishing pre 1996 vehicle fleet may not be cost effective. An OBD-only program for new counties only would be more cost effective but would raise issues of fairness. This change would have to be approved by the VA General Assembly.

Diesel I/M Testing Program

Currently Virginia's I/M program tests only diesels equipped with an on-board diagnostic (OBD) system. This is limited to light-duty (up to 8,500 lbs GVWR) vehicles 1997 and newer but will expand to vehicles up to 10,000 lbs GVWR in model year 2011when OBD will be required on all heavy-duty vehicles up to 14,000 lbs GVWR. Testing non-OBD diesel vehicles as part of the existing I/M program would require new testing equipment. Other states have used an opacity measurement to test diesel exhaust emissions, but this method does not measure NOx emissions and it is uncertain if it adequately measures fine particulate matter PM2.5. Some states have implemented roadside pull-overs to test heavy-duty diesel vehicles. However, most long-haul trucking uses newer vehicles. Generally, it is the local truck fleet that are more polluting.

DEQ is currently investigating using remote sensing to identify high polluting diesel vehicles. One problem is that equipment set for normal passenger vehicles cannot measure exhaust from tall exhaust stacks and is therefore limited to light- and medium-duty diesels.

DEQ could implement diesel I/M by regulation for vehicles up to 10,000 lbs GVWR (and newer that 25 model years). Expanding the vehicle coverage up to 14,000 lbs beginning with model year 2011 for diesels (and model year 2007 for gasoline vehicles) would not require any additional testing equipment, but would require authority from the VA General Assembly.

Vehicle Tailpipe Standards

Adopting the California new vehicle certification standards is an option available to states. To date 13 states have adopted or are in the process of adopting the CA LEV standards (see Appendix 4). Although there is only a small benefit in NOx emissions over the federal Tier 2 standards, the California LEV program offers benefits with respect to reducing greenhouse gas (GHG) emissions. An organization of northeast states, NESCAUM, has calculated that adopting these standards would result in an 18% reduction from a 2002 baseline (non CA GHG standard) GHG emission of 18% in 2020 and 24% in 2030. Their study investigated a wide range of proposed engine efficiency strategies based on currently available technology. Moreover, a cost/benefit analysis, based on $2.00 per gallon gasoline, showed a net vehicle owner savings for all but the most aggressive technologies. Recent gasoline prices would increase these savings even more.

Incentives for Alternative Fuels and Cleaner Vehicles

Following is a discussion of various means which have been proposed to provide incentives for purchasing cleaner fuels and vehicles.

Tax Incentives

The Energy Policy Act of 2005 provides a credit of up to $3150 for certain energy efficient vehicles, including qualified hybrid vehicles based on fuel mileage and sales. The credit begins to phase out after at least 60,000 of the manufacturer's qualifying vehicles have been sold. IRC §30B potentially allows a credit for four separate categories of vehicles: 1) fuel cell vehicles, 2) advanced lean burn technology vehicles, 3) hybrid vehicles and 4) alternative fuel vehicles. Virginia Dept. of Taxation allows a tax credit of 10% of the federal deduction.

Tax credits are not available for dual-fuel vehicles which can operate on either an alternative fuel or gasoline because there is no practical way to regulate which fuel is used. Reduction in fuel taxes is an effective tool to encourage the use of alternative fuels.

HOV Lane Privileges

Some states including Virginia have provided HOV lane privileges to promote clean and alternative fuel vehicles. Section 46.2-749.3. of the Code of Virginia provides for special license plates for certain clean fuel vehicles. Due to HOV lane overcrowding, clean fuel plates for hybrids were limited in 2004 to only the cleanest vehicles that were certified to SULEV or equivalent standards. Later in 2006 the VA General Assembly removed the exemption from the I-95/395 corridor for newly issued plates. EPA is currently finalizing rules which will consider both emissions and fuel economy for HOV lane privileges. The proposed rule in effect mirrors the current list of eligible vehicles closely.

Scrappage Programs

Even though I/M programs can in theory keep vehicles clean, newer vehicles are inherently much cleaner. Also, Virginia's I/M program allows a waiver after spending $680 on repairs. Although most vehicles which receive a waiver are cleaner after these incomplete repairs, for some there is no emissions benefit. Scrappage programs offer an option, perhaps with an additional incentive, to scrap a irreparable vehicle. DEQ in fact looked into developing a scrappage program in the early 1990s. At the time, EPA had very prescriptive requirements in order to receive emissions reduction credits. These requirements essentially precluded reuse of the scrapped vehicle primary components. Old car hobbyists objected vigorously to some of these requirements.

It is possible that less restrictive criteria could be developed and still preserve the benefits of a scrappage program. Such a program could use innovative funding sources from parties who may benefit indirectly from a scrapped vehicle: New car manufacturers and dealers, local tax departments, insurance companies.

V. New Approaches/Technologies

There are number of new additional ways in which to reduce emissions from vehicles that are currently in various stages of development. Some measures such as the use of ethanol, biodiesel and ultra low sulfur diesel are already streaming into the marketplace and are providing for some significant reductions in vehicle emissions. Others are still in the research and development phase or are not yet economically feasible but show promise for the coming years. Listed below along with a brief description of their status and potential effectiveness in reducing vehicle emissions are some of the new technologies and ideas that could help solve the growing global problem with greenhouse gases including ozone precursors and particulate emissions .

Biobutanol

Biobutanol can be produced from the same feedstocks as ethanol, utilizing corn, wheat, sugar beets, sorghum, and other agricultural products. It is compatible with ethanol production processes and can be easily blended with ethanol and gasoline. Biobutanol has a lower vapor pressure than gasoline which reduces the need for gasoline blends to have vapor pressure adjustments to meet fuel specifications. Emission reductions for biobutanol are believed to be comparable to the values achieved with ethanol use. Biobutanol has other advantages over ethanol including; higher energy values, higher blending percentages, better compatibility with conventional engines, and improved stability for transportation in pipelines and tank storage.

Synthetic Diesel Fuels

Diesel fuel typically is derived from refined crude oil and is now being processed to remove most of the sulfur typically associated with diesel. New products in use include low sulfur diesel (LSD) and ultra low sulfur diesel (ULSD). Although this has substantial benefits in reducing much of the emissions of sulfur dioxide and nitrogen oxides from vehicles using diesel, it still relies on the use of crude oil from unfavorable or potentially unstable sources in the Mideast and elsewhere. Synthetic Diesel fuel can be produced from a process which has natural gas as its source. Synthesizing diesel fuel from natural gas is accomplished through a gas to liquid technology known as the Fischer-Tropsch process. The ability to convert natural gas to liquid fuel has been around for many years but has not been economically feasible. Now as the price of crude oil has continued to climb along with the additional cost of making LSD and ULSD, the economics of using synthetic diesel are becoming more attractive. Environmental advantages include zero sulfur emissions and reductions in other contaminants found in refined crude oils. Conversion to significant use of synthetic diesel fuel will take some time as production facilities will have to be built close to new and existing sources of natural gas. This type of fuel may become economically and politically feasible very soon.

Automatic Tire Inflation Systems

A number of companies now offer automatic tire inflation systems on vehicles to improve safety, tire wear and improve gas mileage. The systems monitors tire pressure and either warn the driver that the inflation pressure is low or high so that the tire can be properly inflated or have the ability to automatically adjust air pressure to optimum levels using a separate self-contained air compressor or attachment to the vehicles air brake compressor system. Most of these systems are being used on larger commercial tractor-trailers but can also be used for standard autos. They can be obtained with factory installed purchases of new trucks or retrofitted onto existing vehicles. The advantages are significant with these tire systems:

- Tire life is extended by 8%.
- Eliminates the need to manually check tire pressures which saves time and labor.
- Improves fuel economy by 1%. Can reduce greenhouse gas emissions by one metric ton per year (per truck.)

- Reduces particulate emissions from tire dust caused by increased wear on tires.
- Reduces the chances of a blowout or flat tire.
- Improves safety by always having properly inflated tires.
- Recouping the cost of the ATIS takes less than 2 years due to reduced tire wear, fuel savings and lower maintenance cost.

Aerodynamic Vehicle Designs

Fuel saving technologies are available to upgrade tractor trailers with fairings to reduce wind drag on the front and underside of the vehicle. The kits cost about $2400.00 per vehicle and can achieve a 5% fuel use savings. Many automobiles have already been designed for aerodynamic efficiency to reduce wind drag. All of these actions produce fuel savings by reducing the vehicles exposure to fuel consuming wind resistance.

Idle Reduction Technologies

It is estimated by Argonne National Lab that idle reduction technologies could reduce annual diesel fuel use by the approximately 460,000 long haul trucks now operating in the U.S. by 838 million gallons. If all of the heavy duty trucks in the U.S. used idle reduction technologies, emissions of NOx would be reduced by 140,000 tons, CO by 2400 tons and CO_2 by 140,000 tons annually.

A number of new technologies are available to reduce the amount of fuel used by trucks and tractor trailers when idling at truck stops or other locations. The ability to reduce idling when these vehicles are parked and need power for heaters, conditioners and other on-board devices has other advantages including less wear and tear on the vehicle's engine, reduced noise and of course the elimination of air pollutant emissions that result when trucks are idling. A brief description of some of these technologies are listed below:

<u>Bunk Heaters</u>

These are small light weight heater that mounts in the cab of the truck and runs off of diesel fuel. This device does not provide air conditioning and burns very little fuel while providing comfort in the cab area. The unit costs about $1500.00 and reduces overall fuel savings by about 5% (assuming 1200 hours of idling per year).

<u>Auxiliary Power units</u>

A small diesel powered generator that mounts outside the cab and provides power to run the heater, air conditioner and other electronic devices in the cab. The units cost $6000.00 to $8500.00 and provide about an 8% reduction in fuel consumption assuming 2400 hours per year of idling time. It costs about $5.00 per day to operate the system. As with the bunk heaters there is a significant reduction in vehicle engine wear as well as a reduction in the emissions resulting from truck idling.

<u>On-board Battery Systems</u>

Long lasting rechargeable battery systems are available to run truck cab heaters and air conditioners. Some have their own diesel powered on-board generator to keep the batteries charged up.

<u>Shore Power Installations</u>

Some truck stops have plug-in services available for trucks wired to receive electric current to operate on board systems. A number of truck manufacturers install the electric interface units as a factory installed option. As more and more truck stops offer this service, the cost effectiveness of this idle reduction technology will become more favorable to long haul drivers. The cost per day (about 10 hours idling time) to hook up is only about $2.50. The locations where this service is available are still somewhat spotty and it may take some time to become widely available. Some service companies are sprouting up that jointly operate with truck stop owners to provide hook-ups through a simple window mounted adapter that feeds power to the cab for basic needs including filtered air, internet service, cable TV and telephone.

Automatic Idle Cutoff Systems

Some vehicles, particularly heavy trucks and vehicles used in the construction industry have engine programming in place that automatically cuts off the motor after idling for a certain period of time. This helps reduce the amount of time that an engine is in the idling mode, thereby saving fuel and lowering emissions.

Idle reduction technologies offer some extremely cost effective ways to save on fuel consumption with the resulting reduction in pollutant emissions. With today's high fuel prices the capital markets are moving faster to make some of these technologies more readily available. It costs about $30.00 - $40.00 per day (10 hours idling) for a truck to burn diesel fuel while idling using the vehicle's engine at today's fuel prices. All of the technologies listed above are cheaper to run once the installation and service charges have been paid and pay for themselves in a relatively short period of time (generally less than two years).

Materials Technologies

Weight reduction is one of the most practical ways in which to reduce fuel consumption for all types of vehicles. Advanced materials such as light-weight metals, polymers, composites and intermetallic compounds can be used without sacrificing safety and comfort. The U.S. Department of Energy is directing research in this area and with the continuing high cost of fuel and concern about emissions, the potentially higher cost of some of these newer lightweight materials becomes more practical. One technology that is now available is the use of single wide aluminum-wheeled tires to replace traditional dual tires on tractors and trailers. The approximate cost to replace the tires on a typical tractor trailer would be about $5600.00. The resulting fuel savings would be about 4%. The single wide tires would pay for themselves in relatively short time.

Emission Control Devices

There are some add-on devices that can be installed on tractor trailers to help reduce emissions. One such device is an oxidation catalyst that can be added to a tractor's exhaust system to reduce the emissions of fine particulates and other pollutants. The device costs about $1200.00 and reduces particulate emissions by 20-50%.

Plug in Hybrid Vehicles

Automobile manufacturers are pressing forward with design and research on vehicles that will plug into a standard home electrical outlet. These cars would come with separate batteries that can be charged overnight in the owner's garage and operate for a distance of up to 40 city miles before having to switch back over to gasoline. The gasoline engine when operated would then recharge the batteries giving the car a range of over 600 miles. General Motors recently unveiled their "Volt" auto as a prototype for this type of car. GM awarded two large contracts to work on the enhanced lithium batteries that would be used for the plug in hybrids. Phoenix Motor Cars, a California based company, also is making a small utility truck called the "Phoenix Electric SUT" that can be charged from your home 220 volt outlet. The vehicle will sell for about $45,000. Another plug-in vehicle that will be available in 2008 is the "Tesla Roadstar". About 800 will be made and sells for $98,000, including the installation of a garage charging system.

The plug-in technology has tremendous potential to save fuel and reduce emissions. The plug in approach has the advantage of utilizing electric power from utilities during the night when demand is low and the electricity is cheaper. The challenge facing automakers is to bring the battery costs down and efficiency up to the point where it is cost-effective and the vehicles are marketable.

From well-to-wheel, electric power is still far cleaner than using gasoline according to several studies. Part of the reason is because hybrid vehicles generate their own electric power. Plugging your hybrid into your home is intended to top off the batteries. Even better some companies are developing V2G technology that would enable plug-in hybrid drivers to plug into the grid at work - pumping electricity into the grid during peak hours and making money for the plug-in hybrid owner.

Inevitably, it appears the reality of plug-in hybrids - based upon cost-effectiveness and safety- is easily a few years away from reality, and maybe even as far as the 5 to 10 years claimed by Ford's Alan Mulally. For the next few years, the best action towards achieving mass-produced plug-in hybrids is probably buying one of today's conventional hybrid vehicles.

Fuel Cell Vehicles

Hydrogen fuel cell technology has been around for number of years and has been used in spacecraft and emergency generators. Research is underway to make the technology available for vehicle application. Electricity is produced through a chemical reaction between hydrogen and oxygen. The electricity is then used to feed batteries which are used to power the vehicle's electric engine. The process produces no harmful emissions. The challenge for fuel cell applications is to make the process work in a practical way for automobiles. The Mercedes Benz F-Cell subcompact gets about 57 miles per kg. and has a range of about 110 miles. This limited range is a significant drawback for consumers thinking about using this technology. This problem may be changing as Toyota Motors recently announced that its Highlander Sport Utility traveled 348 miles without refueling. This breakthrough may improve the chances for fuel cell vehicles to become more practical although cost is still an issue in the short term. The success of fuel cell vehicles is also closely wedded to progress with hybrid vehicle development as it depends on reliable and efficient battery systems to power the vehicle. Efforts are also underway to apply some these new hybrid and fuel cell technologies to trucks and buses. Additional research is being conducted on “heavy hybrid propulsion systems” to help make the technology work for the larger vehicles that have low miles per gallon ratings. These heavy vehicles consume large quantities of conventional fuels and release significant amounts of greenhouse gases and other pollutants.

Advanced Combustion Engines

Internal combustion engines will continue to Power transportation vehicles for some time as some of the technologies described above are developed and refined. Therefore, it is important to maximize the efficiency of these engines to reduce fuel use and emissions. The U.S. Department of Energy is sponsoring research that would help reach some goals for improved engine performance for all types of vehicles. Principal areas of research include, minimization of in-cylinder formation of emission gases, after treatment technologies on the exhaust system to further reduce exhaust emissions, waste heat recovery and R&D on all sizes of vehicles to improve combustion processes. One such improvement is being tested by General Motors which could increase fuel efficiency by up to 15%. The technology is called “homogeneous charge compression ignition”. The process involves a flameless low temperature energy release resulting from compression of and air-fuel mixture in the cylinders. GM is testing the technology in a Saturn Aura and Opel Vectra. The process is being refined and GM has no estimate as to when this technology might come to the marketplace.

Other technologies that can be used to reduce fuel consumption include “low roll resistant tires”, “optimal gear shifting programming”, light weight front seats, and other weight reducing options including carbon hood covers. Most of these innovations come at higher cost but can fairly quickly pay for themselves at the current pricing for fuel.

Compressed Natural Gas Vehicles

These vehicles come fitted with tanks to hold compressed natural gas that is used as the fuel for the vehicle. It can be used jointly with gas-powered engines. Emissions are low from burning the natural gas but range is limited (about 170 miles). Fuel usage is about 24/36 in gasoline mpg equivalents.

Land Use Changes

Land use patterns play a direct role in vehicle miles traveled, as a result of the distance that people travel and the mode of travel they choose. Density may have the most profound effect on travel and transportation outcomes, with higher density reducing vehicle miles traveled. The jobs-housing balance will also reduce vehicle miles traveled by shortening commute distances. In addition, the type of housing that California's aging population chooses may affect whether Californians drive more or less as it ages.

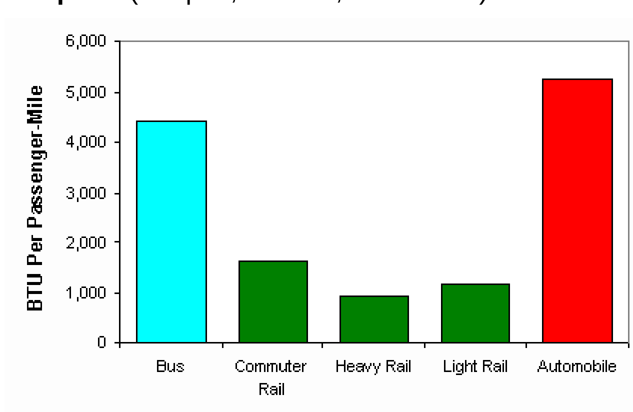
California's land use patterns have shaped energy use in the state and have contributed to the production of greenhouse gases. These patterns include the excessive use of land per household, location away from transit and jobs, preferences for less dense housing, and site designs that require driving rather than walking to meet every day needs. With the state's population expected to grow by 20 million additional residents by 2050, how future land use patterns develop will either help or hinder California in achieving its ambitious energy and climate change goals.

Recent California laws and policies set the stage for how the state will develop its land, use energy, and emit greenhouse gases in the future. Governor Schwarzenegger's Executive Order S 3 05 established greenhouse gas emission reduction targets for 2010, 2020, and 2050; Assembly Bill 32 (Nuñez and Pavley, Chapter 488, Statutes of 2006) implements the 2020 greenhouse gas emission reduction target.

Rail Transportation

Rail transit can provide substantial energy conservation and emission reduction benefits. Rail travel consumes about a fifth of the energy per passenger-mile as automobile travel, due to its high mechanical efficiency and load factors (Figure 26). Electric powered rail produce minimal air and noise emissions. Rail provides even greater energy and emission reduction benefits when it leverages additional reductions in vehicle travel.

Transit Energy Consumption (Shapiro, Hassett, and Arnold)



Rail travel consumes much less energy than bus or automobile travel.

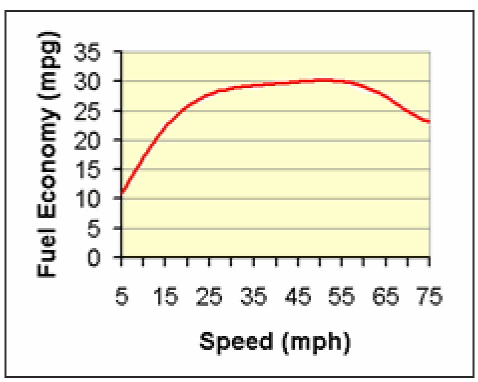
Residents of Large Rail cities drive 12-20% fewer vehicle-miles than residents of Small Rail or Bus Only cities, due to rail's leverage effect on vehicle ownership and land use. This suggests that rail transit can provide about half the per capita transportation CO_2 emission reductions required to meet the Kyoto targets. In addition:

- Rail transit emission reductions can be particularly large since transit oriented development tends to reduce short automobile trips, in which energy consumption and pollution emissions are high per vehicle mile due to cold starts, and because these trips occur under congested conditions. As a result, each 1% of mileage reduced typically reduces air emissions by 2-3%.
- Rail tends to reduce emissions in highly populated areas, such as city centers, major roadways and transit terminals, and so reduces people's exposure to harmful emissions such as CO, toxics and particulates, particularly compared with diesel buses.
- Transit encouragement strategies that increase ridership, and transit oriented development policies, tends to have large energy conservation and emission reduction benefits.
- Energy conservation and pollution emission reductions are just two of many potential benefits of rail transit. When these additional benefits are considered, rail investments can be a cost effective way to achieve environmental objectives.

Driving More Efficiently

A government website (http://www.fueleconomy.gov/feg/driveHabits.shtml) which offers a number of efficient driving tips is quite informative. Some of the tips offered are as follows:

- Aggressive driving (speeding, rapid acceleration and braking) wastes gas. It can lower your gas mileage by 33 percent at highway speeds and by 5 percent around town. Sensible driving is also safer for you and others, so you may save more than gas money.
- While each vehicle reaches its optimal fuel economy at a different speed (or range of speeds), gas mileage usually decreases rapidly at speeds above 60 mph. As a rule of thumb, you can assume that each 5 mph you drive over 60 mph is like paying an additional $0.20 per gallon for gas. Observing the speed limit is also safer.

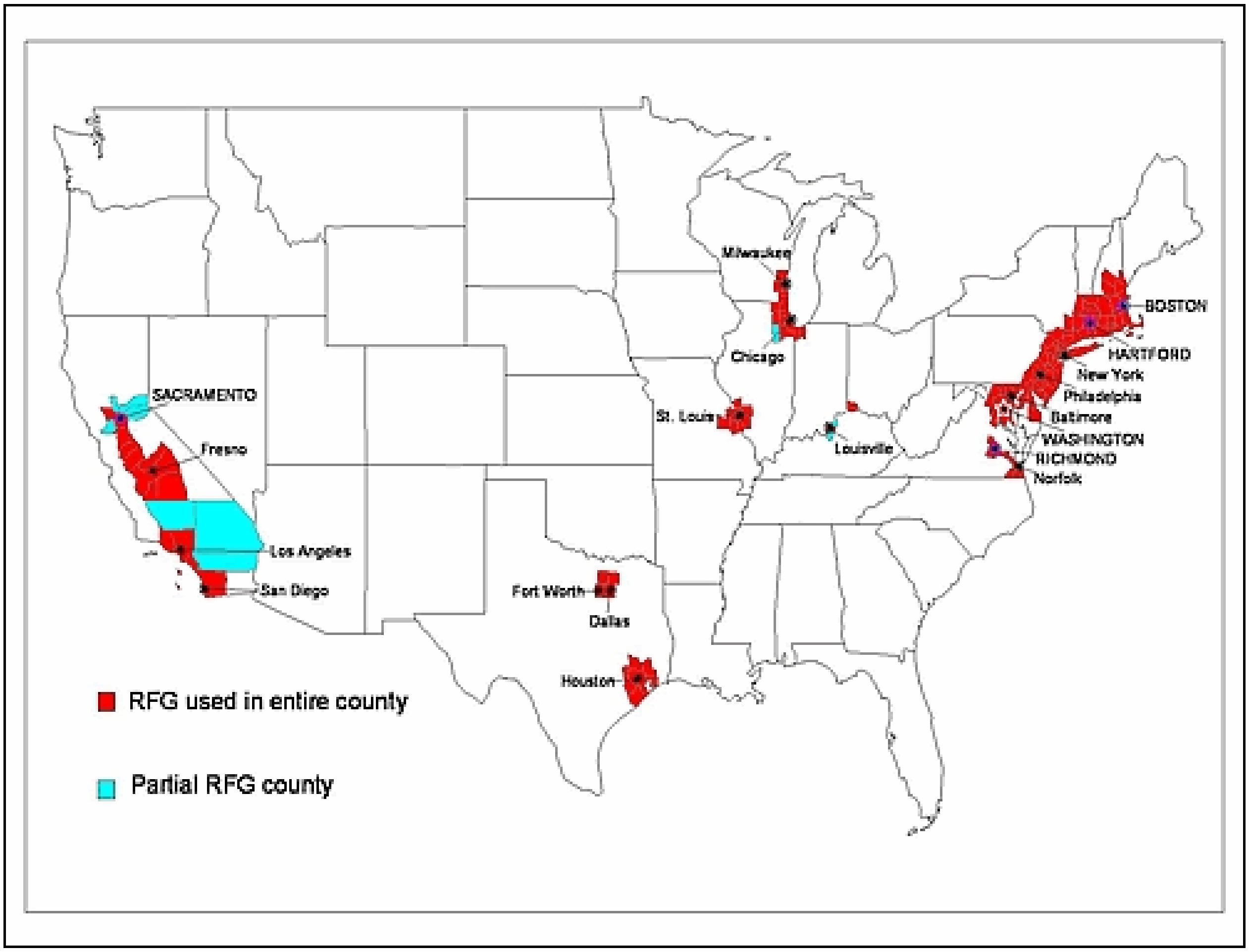


- Idling gets 0 miles per gallon. Cars with larger engines typically waste more gas at idle than do cars with smaller engines. The Department of Energy Park and Wait Program encourages motorists to commit to turn off their engines when stopped for more than 10 seconds. This also calls for the reduction in warming engines to 30 seconds and to turn off engines when parked or when gassing up.
- Carpooling/Rideshare consists of three or more people that commute to work or other destinations in a private vehicle in which members work out their own arrangements on who drives and how often, schedules, and payments for gas and maintenance.
- Mass transit refers to municipal or regional public shared transportation, such as buses, streetcars, and ferries, open to all on a nonreserved basis.   When utilized to any reasonable fraction of their capacity, mass transit vehicles carry a far higher

passenger load per unit of weight and volume than do private vehicles. They also offer fuel savings, not only because of the relative reduction in weight transported, but also because they are large enough to carry more efficient engines. Further, if emphasis is given to mass transit in the planning of future ground transportation systems, smaller rights of way will be possible, lessening the amount of landscape that must be paved over for highways and roads. Although mass transit offers many savings, it does require some sacrifices in personal convenience. These are the necessity to travel on a fixed rather than an individually selected schedule and to enter and disembark from the system only at certain designated locations.

Appendices

Appendix 1 – Map of RFG Use By State



Appendix 2 – Biodiesel Stations In Virginia

*Biodiesel Stations in Virginia**

	ID	Name	Phone	Address	City	State	Zip	Type of Access
	8	Quarters K Citgo - Pentagon/Navy Exchange	703-979-0405	801 S Joyce Street	Arlington	VA	22204	Public - see hours
	50	Courtesy Texaco	804-580-8888	7043 Northumberland Highway	Heathsville	VA	22473	Public - see hours
	124	Duke's Liberty	540-434-8805	710 Port Republic Road	Harrisonburg	VA	22801	Public - see hours
	125	Express Stop Winchester - Holtzman Express	800-628-0379	1511 Martinsburg Pike	Winchester	VA	22603	Public - see hours
	126	East End Exxon	540-743-4993	717 Main Street	Luray	VA	22835	Public - see hours
	127	Leesburg Liberty	703-777-6600	2 Harrison Street	Leesburg	VA	20175	Public - see hours
	191	NASA - Langley Research Center	757-864-1000	2 East Ames Street	Hampton	VA	23681	Private - government only

Appendix 3 – Ethanol 85% (E85) Stations In Virginia

*Ethanol 85% Stations in Virginia**

	ID	Name	Phone	Address	City	State	Zip	Type of Access
	972	Office of Fleet Management Services		2400 West Leigh Street	Richmond	VA	23220	Private - government only
	1125	Virginia Office of Fleet Management Services			Dale City	VA	22193	PLANNED - not yet accessible
	1126	Virginia Office of Fleet Management Services			Williamsburg	VA	23186	PLANNED - not yet accessible
	47	Quarters K Citgo - Pentagon/Navy Exchange	703-979-0405	801 S Joyce Street	Arlington	VA	22204	Public - see hours
	737	Marine Corps Base - Quantico			Quantico	VA	22134	PLANNED - not yet accessible
	698	Yorktown Naval Weapons Station		Yorktown Naval Weapons Station	Yorktown	VA	23691	Private - government only
	697	Norfolk Naval Shipyard		Norfolk Naval Shipyard	Portsmouth	VA	23709	Private - government only
	272	NASA - Langley Research Center		2 East Ames Street	Hampton	VA	23681	Private - government only
	240	Fort Belvoir			Fort Belvoir	VA	22060	PLANNED - not yet accessible

*Source-US Department of Energy-Alternative Fuels Data Center

Appendix 4 – List of States That Adopted California Vehicle Standards

State/Jurisdiction	CA Vehicle Standards?	Effective Model Year	ZEV Requirement?	CA Green House Gas Emssions Standard
California	CA LEV	1992	10% ZEV by 2004?	Yes
Connecticut	CA LEV	2008	10% ZEV by 2008	Yes
Florida	CA LEV	initiating rulemaking		
Maine	CA LEV	2001	10% ZEV by 2008	Yes
Maryland	CA LEV	2011	?	Yes
Massachusetts	CA LEV	1994	10% ZEV by 2008	Yes
New Jersey	CA LEV	2009	10% ZEV by 2009	Yes
New York	CA LEV	1992	10% ZEV by 2008	Yes
Oregon	CA LEV	2009	10% ZEV by 2009	Yes
Pennsylvania	CA LEV	2008	no ZEV requirement	No
Rhode Island	CA LEV	2008	10% ZEV by 2008 16% ZEV by 2018	Yes
Vermont	CA LEV	2000	10% ZEV by 2007	Yes
Washington	CA LEV	2009	no ZEV requirement	Yes

Appendix 5 – Federal Tier 1 Emissions Standards

EPA Tier 1 Emission Standards for Passenger Cars and Light-Duty Trucks, FTP 75, g/mi

Category	50,000 miles/5 years						100,000 miles/10 years[1]					
	THC	NMHC	CO	NOx† diesel	*NOx gasoline*	PM	THC	NMHC	CO	NOx† diesel	*NOx gasoline*	PM
Passenger cars	0.41	0.25	3.4	1.0	*0.4*	0.08	-	0.31	4.2	1.25	*0.6*	0.10
LLDT, LVW <3,750 lbs	-	0.25	3.4	1.0	*0.4*	0.08	0.80	0.31	4.2	1.25	*0.6*	0.10
LLDT, LVW >3,750 lbs	-	0.32	4.4	-	*0.7*	0.08	0.80	0.40	5.5	0.97	*0.97*	0.10
HLDT, ALVW <5,750 lbs	0.32	-	4.4	-	*0.7*	-	0.80	0.46	6.4	0.98	*0.98*	0.10
HLDT, ALVW > 5,750 lbs	0.39	-	5.0	-	*1.1*	-	0.80	0.56	7.3	1.53	*1.53*	0.12

1 - Useful life 120,000 miles/11 years for all HLDT standards and for THC standards for LDT

† - More relaxed NOx limits for diesels applicable to vehicles through 2003 model year

Abbreviations:

LVW - loaded vehicle weight (curb weight + 300 lbs)

ALVW - adjusted LVW (the numerical average of the curb weight and the GVWR)

LLDT - light light-duty truck (below 6,000 lbs GVWR)

HLDT - heavy light-duty truck (above 6,000 lbs GVWR)

Appendix 6 – EPA Tier 1 SFTP Standards

Supplemental Federal Test Procedure Standards (SFTP)

In addition to the FTP 75 test, a Supplemental Federal Test Procedure (SFTP) was phased-in between 2000 and 2004. The SFTP includes additional test cycles to measure emissions during aggressive highway driving (US06), and also to measure urban driving emissions while the vehicle's air conditioning system is operating (SC03).

The Tier 1 SFTP standards, which applied to NMHC+NOx and CO emissions, are summarized below. The NMHC+NOx standards are weighted, while CO standards are standalone for US06 and SC03 with an option for weighted standard. Weighting for NMHC+NOx and optional weighting for CO is SFTP = 0.35 × FTP + 0.28 × US06 + 0.37 × SC03. Intermediate life (50,000 mi) standards are shown in parentheses.

EPA Tier 1 SFTP Standards

Category*	NMHC+NOx, g/mi	CO, g/mi		
	Weighted	US06	SC03	Weighted
Passenger cars & LLDT, LVW <3,750 lbs	0.91/2.07† (0.65/1.48†)	11.1 (9.0)	3.7 (3.0)	4.2 (3.4)
LLDT, LVW >3,750 lbs	1.37 (1.02)	14.6 (11.6)	4.9 (3.9)	5.5 (4.4)
HLDT, ALVW <5,750 lbs	1.44 (1.02)	16.9 (11.6)	5.6 (3.9)	6.4 (4.4)
HLDT, ALVW >5,750 lbs	2.09 (1.49)	19.3 (13.2)	6.4 (4.4)	7.3 (5.0)

* See note to Table 1 for abbreviations

† The more relaxed value is for diesel fueled vehicles

Appendix 7 – Federal Tier 2 Standards for Light-Duty Vehicles

Table 2
Tier 2 Emission Standards, FTP 75, g/mi

Bin#	Intermediate life (5 years / 50,000 mi)					Full useful life				
	NMOG*	CO	NOx	PM	HCHO	NMOG*	CO	NOx†	PM	HCHO
Temporary Bins										
11 MDPV[c]						0.280	7.3	0.9	0.12	0.032
10[a,b,d,f]	0.125 (0.160)	3.4 (4.4)	0.4	-	0.015 (0.018)	0.156 (0.230)	4.2 (6.4)	0.6	0.08	0.018 (0.027)
9[a,b,e,f]	0.075 (0.140)	3.4	0.2	-	0.015	0.090 (0.180)	4.2	0.3	0.06	0.018
Permanent Bins										
8[b]	0.100 (0.125)	3.4	0.14	-	0.015	0.125 (0.156)	4.2	0.20	0.02	0.018
7	0.075	3.4	0.11	-	0.015	0.090	4.2	0.15	0.02	0.018
6	0.075	3.4	0.08	-	0.015	0.090	4.2	0.10	0.01	0.018
5	0.075	3.4	0.05	-	0.015	0.090	4.2	0.07	0.01	0.018
4	-	-	-	-	-	0.070	2.1	0.04	0.01	0.011
3	-	-	-	-	-	0.055	2.1	0.03	0.01	0.011
2	-	-	-	-	-	0.010	2.1	0.02	0.01	0.004
1	-	-	-	-	-	0.000	0.0	0.00	0.00	0.000

* for diesel fueled vehicle, NMOG (non-methane organic gases) means NMHC (non-methane hydrocarbons)
† average manufacturer fleet NOx standard is 0.07 g/mi for Tier 2 vehicles

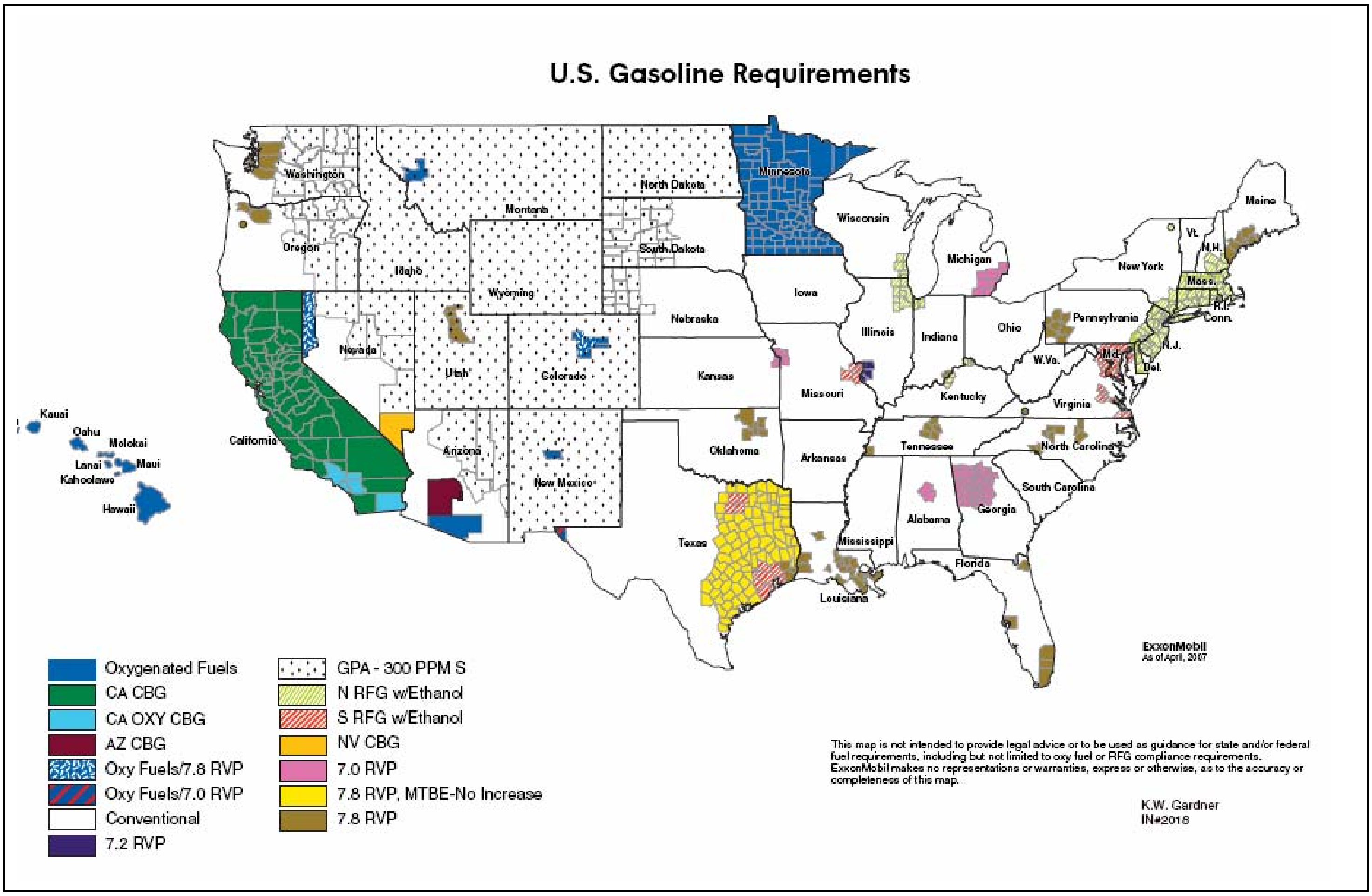
a - Bin deleted at end of 2006 model year (2008 for HLDTs)
b - The higher temporary NMOG, CO and HCHO values apply only to HLDTs and MDPVs and expire after 2008
c - An additional temporary bin restricted to MDPVs, expires after model year 2008
d - Optional temporary NMOG standard of 0.195 g/mi (50,000) and 0.280 g/mi (full useful life) applies for qualifying LDT4s and MDPVs only
e - Optional temporary NMOG standard of 0.100 g/mi (50,000) and 0.130 g/mi (full useful life) applies for qualifying LDT2s only
f - 50,000 mile standard optional for diesels certified to bins 9 or 10

Appendix 8 – California LEV II Emission Standards, Passenger Cars and LDVs < 8500 lbs

California LEV II Emission Standards, Passenger Cars and LDVs < 8500 lbs, g/mi										
Category	50,000 miles/5 years					120,000 miles/11 years				
	NMOG	CO	NOx	PM	HCHO	NMOG	CO	NOx	PM	HCHO
LEV	0.075	3.4	0.05	-	0.015	0.090	4.2	0.07	0.01	0.018
ULEV	0.040	1.7	0.05	-	0.008	0.055	2.1	0.07	0.01	0.011
SULEV	-	-	-	-	-	0.010	1.0	0.02	0.01	0.004

California LEV II Emission Standards, Medium Duty Vehicles, Durability 120,000 miles, g/mi						
Weight (GVWR), lbs.	Category	NMOG	CO	NOx	PM	HCHO
8,500 - 10,000	LEV	0.195	6.4	0.2	0.12	0.032
	ULEV	0.143	6.4	0.2	0.06	0.016
	SULEV	0.100	3.2	0.1	0.06	0.008
10,001 - 14,000	LEV	0.230	7.3	0.4	0.12	0.040
	ULEV	0.167	7.3	0.4	0.06	0.021
	SULEV	0.117	3.7	0.2	0.06	0.010

Appendix 9 – Map Showing U.S. Gasoline Requirements



Key for abbreviations-US Gasoline Requirements map:

CA CBG …………California Clean Burning Gasoline

AZ CBG………… Arizona Clean Burning Gasoline

NV CBG………… Nevada Clean Burning Gasoline

RVP …………… Reid Vapor Pressure (measure of the evaporation level in gasoline)

GPA-300 PPM S…. Geographical Phase- in Area (requiring 300 parts per million maximum sulfur content in fuel.)

RFG………………. Reformulated Gasoline

MTBE…………….Methyl tertiary-butyl ether (use phasing out)

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